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Device for radio-based issuing of warnings of hazards

The invention relates to a device for radio-based issuing of warnings of hazards according to the preamble of claim 1.

EP 927 983 A2 describes a device for radio-based issuing of warnings of hazards, with vehicles being equipped with one data transmitter and one data receiver each in order to exchange data relating to warnings of hazards. After the data transmitter has been activated, the data relating to the hazard warning is transmitted to other motor vehicles, with the transmitted data comprising information relating to the position, the speed and the direction of travel of the transmitting vehicle. In the receiving vehicle, the received data is evaluated to determine whether or not a hazard lies ahead of the vehicle. If a hazard is detected, this is conveyed to the driver by warning signals.

FR 2 793 056 describes a device for issuing warnings of hazards, in which device the type of hazard is indicated in the vehicle. In the receiving vehicle it is determined whether it is necessary to output the warning to other vehicles.

WO 01/61668 A1 describes a device for issuing warnings of hazards, in which device a warning zone is generated in the transmitting vehicle and is output together with the hazard warning. In the transmitting vehicle, the position of the vehicle and the type of road on which the vehicle is located is determined using a navigation system. The speed difference between the speed of the

transmitting vehicle and the typical or maximum speed of other vehicles on the given type of road is included in the calculation of the warning zone in the transmitting vehicle. The evaluation of the received hazard warning in the receiving vehicle is carried out using a navigation system by checking whether the receiving vehicle is in the warning zone and whether the hazard warning relates to a section of road which possibly lies in front of the receiving vehicle.

The document "WARN - ein neues funkbasiertes Gefahrenwarnsystem im Kfz für mehr Sicherheit im Straßenverkehr" [WARN - a new radio-based hazard warning system in motor vehicles for providing more safety in road traffic], Brenzel, C., Hickel, F., Paßmann, C., VDI Berichte [VDI Reports] No. 1415, 1998 discloses that, together with the hazard warning, the type of hazard, the speed of the transmitting vehicle and information about the position of the transmitting vehicle can be transmitted. In the receiving vehicle, the difference in speed with respect to the transmitting vehicle is determined. Information about the position of vehicles is used to determine whether the warning message has been generated by a vehicle traveling in front or a vehicle traveling behind or by the oncoming traffic.

The document "Wireless Vehicle to Vehicle Warning System", Paßmann, C., Brenzel, C., Meschenmoser R., SAE-Paper, 2000-01-1307, discloses that a check is made in the receiving vehicle as to whether the transmitting vehicle is located in front of or behind the receiving vehicle.

DE 199 52 392 A1 discloses a method in which warning information which is dependent on the route is made available to the driver. By means of digital road maps

it is detected, for example, whether the driver is approaching a bend lying ahead. If the current speed of the vehicle is higher than a speed limit for the bend, the driver is first warned visually. If the driver does not react to the visual warning within a certain time, i.e. if he continues to drive with unreduced speed, an additional audible warning is issued. Since the bend has a fixed position, the approach to a bend is always detected at a sufficiently large distance ahead of the bend, and various warning stages of increasing urgency are successively triggered.

The invention is then based on the object of implementing an improved device for issuing warnings of hazards with improved detection of relevant hazard warnings.

This object is achieved by means of the features of claim 1. The dependent claims relate to advantageous embodiments and developments of the invention.

The device for radio-based issuing of warnings of hazards generates a hazard warning which extends beyond the visual range of a hazard warning system. This provides an electronic lengthening of the classic hazard warning system. A significant component of the device is a radio modem which permits the direct exchange of data between vehicles in real time and with a sufficiently large range, approximately 1 km. In addition, the device optionally includes a locating module with which the position of the vehicle can be determined by locating means. This locating module may be a component of a navigation system or be connected to a navigation system. If the locating module is connected to a navigation system or is a component thereof, the position of the vehicle can be determined with even greater accuracy because the measured

position of the vehicle can be represented on the digital map which is present in the navigation system by map matching. As a result, errors in the determination of a position can be compensated by the locating module.

The data which is received by the transmitting vehicle comprises here information on the position of the transmitting vehicle. This information relating to the position comprises positions which have been determined by a locating device and/or a directional course of the vehicle. A directional course of the vehicle is formed from the direction of travel and speed of the vehicle at various times. The received information relating to the position optionally also includes additional information about earlier positions of the transmitting vehicle. The earlier positions of the vehicle form a position chain of the vehicle which is composed of a sequence of points at which information relating to the position of the vehicle is present. In this context, the position chain can be a directional course and/or a sequence of positions which are determined by means of a locating system or navigation system.

A relevance measure is determined from the received data of the transmitting vehicle and the position, speed and direction of travel data of the receiving vehicle, said relevance measure expressing the probability of the transmitting vehicle being located on the section of road lying in front of, that is to say downstream of, the receiver. The receiving vehicle advantageously has information about the route which is used to estimate in advance the future route of the receiving vehicle. The relevance measure which expresses the probability of the transmitting vehicle being located on the predicted future route of the receiving vehicle is advantageously determined here

from the received data of the transmitting vehicle and the predicted future route of the receiving vehicle. Determining the chronological profile of the relevance measure makes possible more reliable detection of relevant locations of hazards.

In one advantageous embodiment of the invention, incorrect warnings are detected by means of the chronological profile of the relevance measure. Information is advantageously output as a function of the relevance measure determined. This means, for example, that information whose relevance measure is too low is not output.

In one advantageous development of the invention, the outputting of information to the driver is terminated as soon as a warning is detected as an incorrect warning. In this context, it is advantageous if, as soon as the outputting of information is terminated owing to an incorrect warning, the driver is explicitly informed, by means of a directly following information output, that the previously reported hazard is no longer relevant to him.

The invention prevents, for example, mass pileups which occur, for example, on freeways and in which a plurality of vehicles are involved and which are often due to poor visibility conditions, for example fog, on sections of road with poor visibility, for example before a bend which cannot be seen into satisfactorily or owing to traffic disruption, for example the end of congestion, roadworks. The device for radio-based issuing of warnings of hazards makes it possible for the drivers of vehicles behind to detect the hazard ahead in good time so that they are then capable of braking their vehicle in good time. In one development of the invention it is possible to provide for the

vehicle to be braked automatically by an intervention in the vehicle control systems.

In one advantageous development of the invention, the device for radio-based issuing of warnings of hazards comprises a data transmitter which is triggered, for example, by the hazard warning system of the vehicle. If the hazard warning system of a vehicle is triggered in this embodiment of the invention, a corresponding radio message is emitted to all the vehicles in the vicinity of the transmitting vehicle. The transmitted data of each transmitter comprises here its current speed and its position chain. In one embodiment of the invention it is also possible for the transmitter to transmit its identification number and/or a type of hazard.

Preferred exemplary embodiments of the invention are described below with reference to the associated drawings, in which:

In this context the single figure is a block diagram of a device for radio-based issuing of warnings of hazards.

As is apparent from fig., the device for radio-based issuing of warnings of hazards comprises a data receiver unit 10, data transmitter unit 15 and a computer unit 20. The device for radio-based issuing of warnings of hazards is preferably connected to a navigation system 30, an output unit 40, an activation device 50 and a sensor unit 60 via a vehicle bus system. The sensor unit may comprise a plurality of different sensors, in particular a crash sensor, a speed sensor etc. The activation device 50 may be, for example, the hazard warning system of the vehicle.

The position information which is output by a transmitting vehicle advantageously comprises a directional course of the vehicle, formed from the direction of travel and speed of the vehicle at various times. Alternatively or additionally, the information about the position is generated by a navigation system 30; this is advantageously carried out using a locating device, for example GPS. The type of road and the direction of travel can also be determined using a navigation system 30. The determination of the position, type of road and direction of travel by means of a navigation system 30 is described in WO 01/61668 A1 and is incorporated here by reference. The determination of the position, type of road and direction of travel using directional courses of vehicles is described in EP 0 927 983 A2 and is incorporated here by reference.

A position chain of a vehicle is composed of a sequence of points at which information relating to the position of the vehicle is present. The position chain may be a directional course and/or a sequence of positions which are determined by means of a locating system or navigation system 30. The position chain describes the geometry of the route covered by the transmitter in the recent past. The receiving vehicle, the receiver, can check, by means of a comparison of its own position chain with the position chain of the transmitter, whether the routes covered up to now by both vehicles are identical and whether the transmitting vehicle, the transmitter, is ahead of the receiving vehicle, the receiver, that is to say downstream of it, or behind the receiving vehicle, the receiver, that is to say upstream of it. The result of this comparison is expressed by a relevance measure. For example, on freeways it is possible to detect whether the transmitter is located on the same carriageway ahead of

the receiver or on the opposite carriageway. If the transmitting vehicle is located ahead of the receiving vehicle on the same carriageway, the relevance measure is large and the driver of the receiver must be warned before the signaled hazard. If the transmitting vehicle is located behind the receiving vehicle or on the opposite carriageway, the relevance measure is small and the received hazard message has no significance for the driver of the receiver.

A further advantage of the device described here is the detection of incorrect warnings. An incorrect warning is to be understood as a warning which warns the driver of a hazard which is not located on his future route. There are certain situations in which an incorrect warning is unavoidable. If the transmitter is, for example, just after a fork in the carriageway, for example on the left-hand branch, the driver of the receiver must be warned in good time of the signaled hazard even if at the time when the warning is triggered it is not yet even known whether the receiver will travel on the left-hand or right-hand branch of the fork. Irrespective of the future decision to make a turn, the relevance measure of the transmitter is sufficiently large to trigger a warning. However, after the fork is reached the further course of the relevance measure depends on whether the receiver travels along the left-hand or right-hand branch of the fork. In the first case, the position chains of the transmitter and receiver continue to correspond satisfactorily, the relevance measure remains high and the warning is maintained. In the second case, the position chains of the transmitter and receiver diverge and the relevance measure drops. If it drops below a certain threshold value, it is possible to assume that the transmitter and receiver are then located on different routes and the warning has been incorrectly triggered. An

incorrect message is therefore detected by the trailing edge of the relevance measure. If this is the case, not only is the warning terminated but the driver is also explicitly informed that the previously signaled hazard is no longer relevant to him. This prevents the driver losing confidence in the radio warning system owing to incorrect warnings which are unavoidable under certain circumstances, or the driver being surprised by the apparently inexplicable disappearance of the warning.

The hazard warning can also be refined by route information which can be obtained, for example, from a digital road map. On the one hand, it is possible to use the route information to predict the future route of the transmitter at least as far as the next intersection point. As a result, the position chain of the transmitter can be lengthened and the reliability of the relevance measure, which reliability depends on the length of overlap between the position chains of the transmitter and receiver, can be increased. Furthermore, with the previewing of route it is possible to determine the distance between the transmitter and receiver more accurately because the precise geometry of the part of the route lying between the two vehicles is known. Likewise, incorrect warnings can in certain situations be avoided by means of the route information. If, for example, it is detected that a transmitter is located after a fork, then only warning levels of high urgency can be permitted, ensuring that the distance threshold for the triggering of the warning is located after the fork so that it is possible to wait to see whether after the fork the receiver will travel on the same branch as the transmitter or select the other alternative route.

The driver is advantageously warned as long as radio messages are received and the transmitter is located

ahead of the receiver. However, it is necessary to take into account the fact that temporary disruption of the communication link may occur as a result of external influences. For this reason, with the device described here if further radio messages are not received, this is initially interpreted as a temporary interruption in the communication link and not as a deactivation of the transmitter. The warning is furthermore maintained and the relative movement of the receiver with respect to the transmitter is continued on the assumption that the transmitter continues moving with its last-known speed. The warning is terminated only if no more radio messages are received for a sufficiently long time, but at the earliest after a minimum warning time, which ensures that the driver can also perceive the indicated warning.

A warning is also terminated if the driver of the receiver indicates, by switching on his own hazard warning system, that he has detected the signaled hazard. The switching-on process of the hazard warning system, and not the state "hazard warning lights on" is advantageously used as a criterion for the termination of the warning since otherwise the driver would not receive any warning if he were to approach a transmitter with his hazard warning system already switched on because, for example, he is towing another vehicle. The possibility of switching on his own hazard warning system is an advantageous way for the driver of acknowledging a warning and thus terminating it manually. The restriction to this type of acknowledgement keeps the system simple. However, more wide-ranging operating control actions are conceivable.

A warning is also terminated automatically if the approach speed of the receiver to the transmitter or the absolute speed of the receiver become very low.

This prevents, for example, a display in the vehicle being blocked for an unnecessarily long time.

Scenarios are conceivable, for example when a vehicle is approaching the end of a traffic jam, in which a plurality of transmitters emit radio messages simultaneously.

With the system described here, the radio messages of any desired number of transmitters can be processed in parallel. Successive radio messages from the same transmitter are recognized on the basis of their common identification number. At first, individual checking is carried out for each transmitter to determine which relevance measure is to be assigned to it.

In order to determine the chronological profile of the relevance measure for each of the transmitting vehicles, the relevance measure is determined for each transmitting vehicle at time intervals. By means of the chronological profile it is then possible, for example, to determine which messages are incorrect messages.

In terms of the types of hazard a distinction is made between a general hazard, a virtual warning triangle, an accident and roadworks. The general hazard type of hazard is transmitted if the driver has manually triggered the hazard warning system and the engine of the vehicle is running, for example when approaching the end of a traffic jam. The virtual warning triangle type of hazard is transmitted if the driver has triggered the hazard warning system manually and the engine of the vehicle is off, for example because the vehicle has broken down. The accident type of hazard is transmitted if the hazard warning system has been triggered automatically by the crash sensor of the vehicle. And finally, the roadworks type of hazard is

not transmitted by vehicles but rather by beacons which mark the start of roadworks.

The driver can be informed visually and/or audibly about the hazard lying ahead. The visual outputting is carried out by means of a display which is mounted in the vehicle. Said display is preferably integrated in the combination instrument and is thus located in the primary field of vision of the driver. At said location, the attention of the driver can advantageously be diverted to the hazard warning by means of a visual output. The visual warnings can also be supplemented by audible signals or voice outputs in order to ensure reliable perception of the warning even if the driver's gaze is averted from the combination instrument because he is, for example, operating the radio or some other operating device mounted in the center console or is concentrating completely on observing the surrounding traffic situation.